USER GUIDE

# Turn Table Assembly Station

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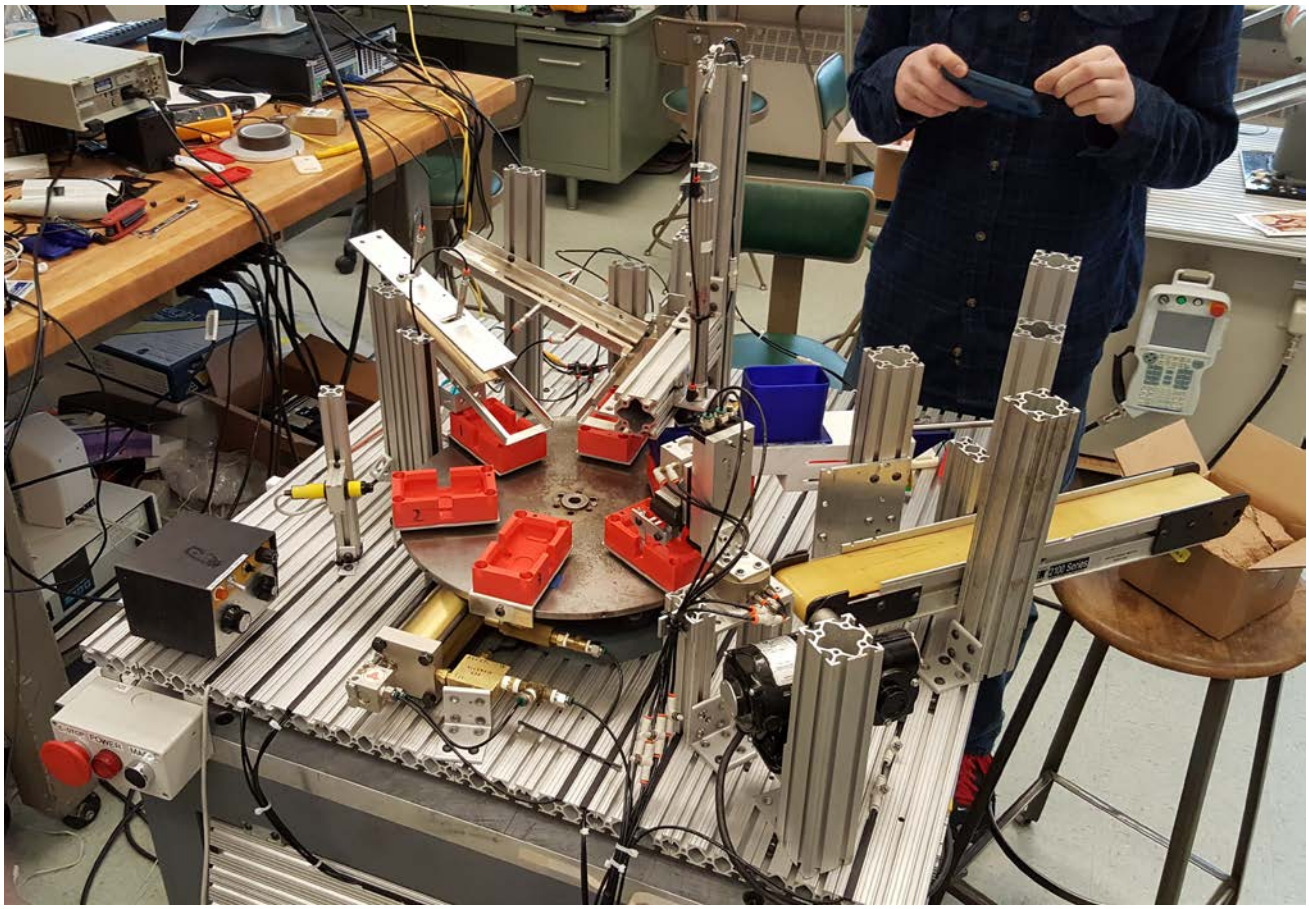
# USER GUIDE

## 1 Introduction



### 1.1 Scope and Purpose

The turn table assembly station is used to assemble parts with as short of a cycle time as possible. This station has the added features of being configured to assemble headlamps with four stages at a rate of one headlamp assembled every 7 seconds approximately. It features three gravity fed magazines in the assembly process as well as a stage that picks up and places the assembled headlamps on a moving conveyer belt to be counted and packaged.

This guide is here to help with the use of this assembly station and aid in your configuration of the station to fit your needs. We will cover how the station is assembled, the electronic management of the process, and the code that is used to control the station. It is expected that users will be familiar with PLC programing and basic manufacturing processes.

### 1.2 Process Overview

The assembly station is composed of six main parts: four assembly stations, a clockwise turn table set to rotate 1/12$^{th}$ of the circumference when triggered, and a PLC. The PLC controls all the movement of the stages through use of air powered pneumatics. The turn table is used to hold the parts in a jig as they are being assembled and move each partial

assembly to the next stage as needed. Each stage is numbered 1-4 and help to complete an additional part of the assembly. Stage one is used to feed the face of the headlamp into the jig, stage two adds the electronics assembly, stage three places and secures the back, and stage 4 picks the completed assembly out of the jig and places it on a running conveyor belt.

# 2 Turn Table

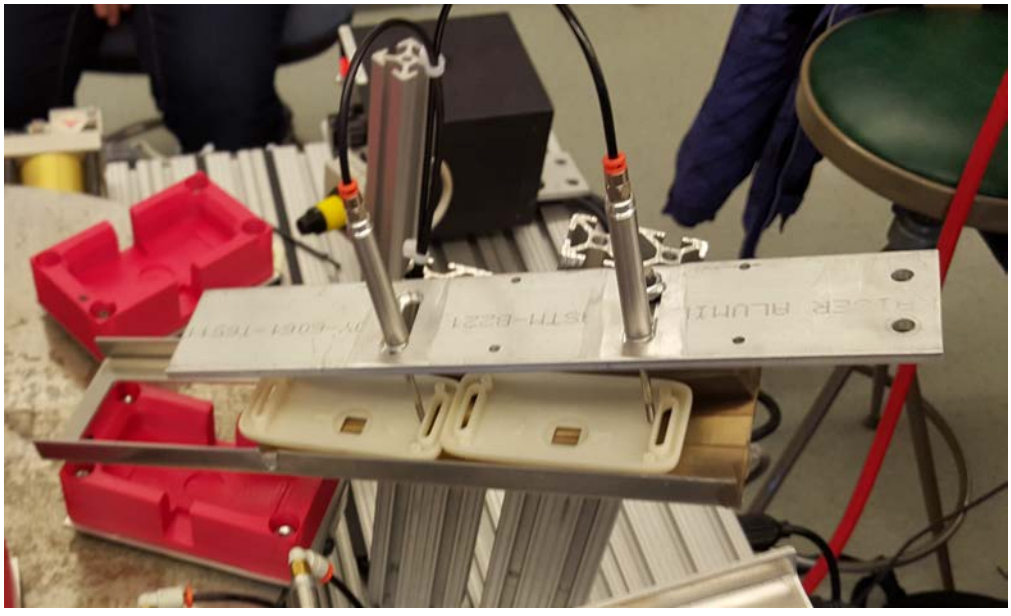
The turntable that is being used should rotate clockwise and have 12 separate mounts available. Six parts made of 16-gauge aluminum have been provided. Each part has a 90-degree bend with four holes drilled in the large face and one hole drilled in the small face. The single hole is used to attach the part to the turn table. The four holes are used to mount your jig to the turn table. This will help allow for consistent and repeatable results as each jig can then be adjusted to be in the same orientation with a fair amount of precision.

In the current setup, the jigs have been mounted on every other mount point to allow for the size restriction. To allow for other configurations, use ¼ in.-20 bolts to mount the parts to the turn table. Use 1/4in.-20 cap head bolts to mount the jigs to the parts.

# 3 Stage 1 – Front Face

Stage one is used to feed the front face into the jig. The stage is composed of the following parts: one magazine made of 16-gauge aluminum, two small pneumatic cylinders approximately 2 inches in length, one aluminum sheet for mounting the pneumatics with two slots machined out used for mounting to the frame as well, Teflon tape, rubber sponge tape approx. 3/8in thick.

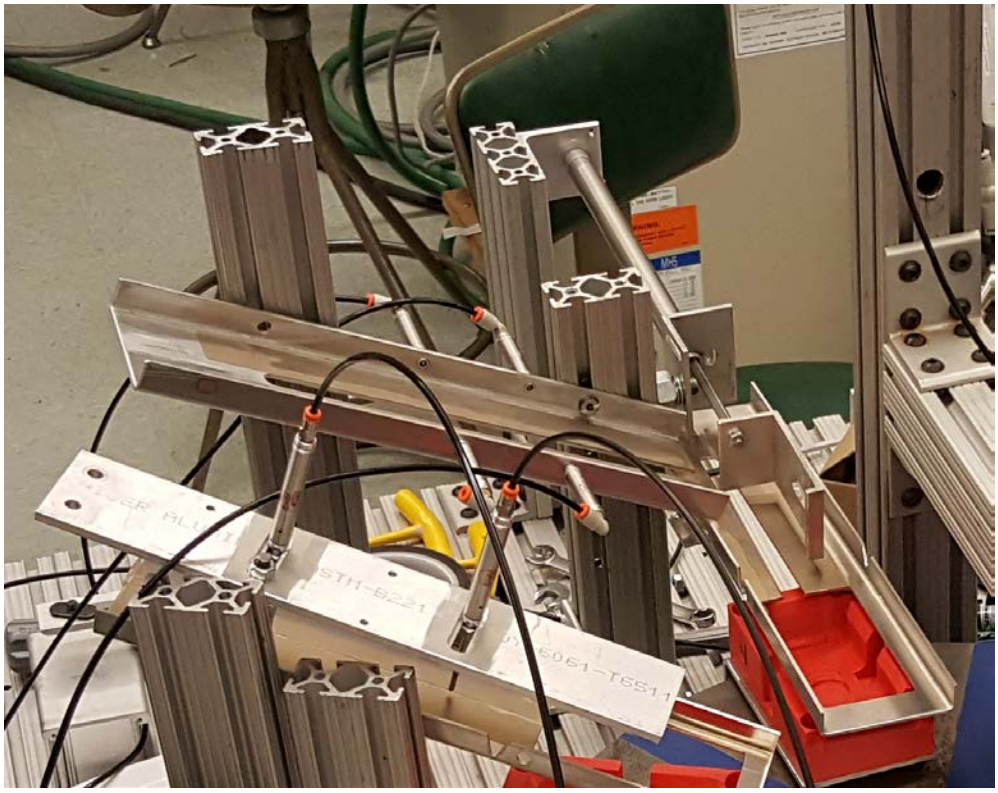
The magazine is slightly wider than the height of the front face, with rubber sponge tape on either edge of it to aid in alignment. The Teflon tape is placed on the sides and bottom of the magazine to help the parts slide smoothly. The two pneumatic cylinders (the one on the left being called first and the one on the left being called second) are mounted above the magazine in such a way that when they pistons are extended they catch the edge of the front face. A hole has been machined out of the end of the magazine to allow the parts to drop through into the jig.



# 4 Stage 2 – Electronics Package

Stage two is used to feed the electronics package into the jig where the front face is already sitting. This stage is composed of the following parts: one magazine manufactured out of 16-gauge aluminum, one feeder tray, four small 1in. pneumatic cylinders, one medium approximately 8 in pneumatic cylinder, one alignment pneumatic head, Teflon tape, and 3/8in rubber foam tape.

The magazine is mounted at 90-degrees to the feeder tray and at an angle to allow gravity to feed the parts. The four small pneumatic cylinders are set to allow the first electronics package down to feeder tray, then move the second package to the first packages place. The magazine tray has a channel cut into it that is approx. 11 mm wide where the electronics lens fits. The magazine is also lined with Teflon tape to aid with gravity feeding. Once the electronics package makes it to the feeder tray, it is enclosed in the alignment pneumatic head which is mounted to the end of the medium pneumatic. This head pushes the electronics package down the feeder tray and keeps it in the proper orientation for assembly. The feeder tray has rubber foam tape lining the sides to ensure that the electronics are placed as accurately and reliably as possible and Teflon tape to aid in movement. A rectangular hole has been machined out of the end of the feeder tray to allow the electronics into the jig.



# 5 Stage 3 – Back Face

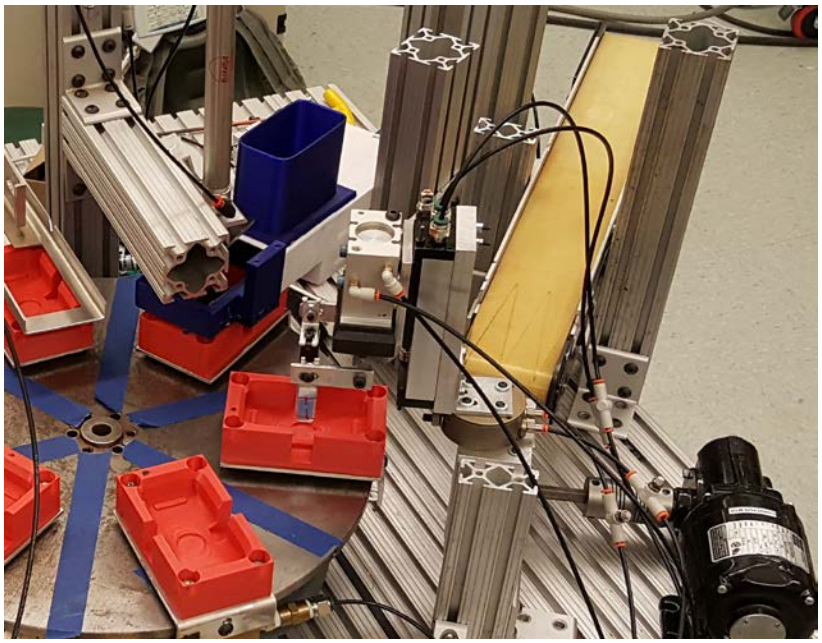
Stage three is used to place the back face into the jig and secure it, completing the assembly. This stage is composed of the following parts: a spring-return pneumatic cylinder, a 3D printed magazine, a 3D printed loader, a 3D printed mount, a 3D printed brush part holder, a double-acting pneumatic cylinder, and a plate to distribute the force of the double-acting cylinder across the headlamp.

The purpose of this stage is to place and press on the back piece of the headlamp assembly. First, a back piece falls down in the magazine and is pushed into the 3D printed brush part holder by the spring-return cylinder which is connected to the 3D printed loader which makes sure that only one part comes from the magazine at a time. The brushes then hold the back part in the right place, ready for the double-acting cylinder to come down from the top, pushing the back piece through the brushes and into the jig on top of the rest of the assembly. The double-acting cylinder retreats for a fraction of a second and then presses again to ensure that the back and front pieces are snapped together as well as possible. The plate attached to the double-acting cylinder is used to distribute the force to the corners of the back piece instead of just the center. The 3D printed mount and t-slot aluminum extrusion hold this all together.

# 6 Stage 4 – Removal from Jig

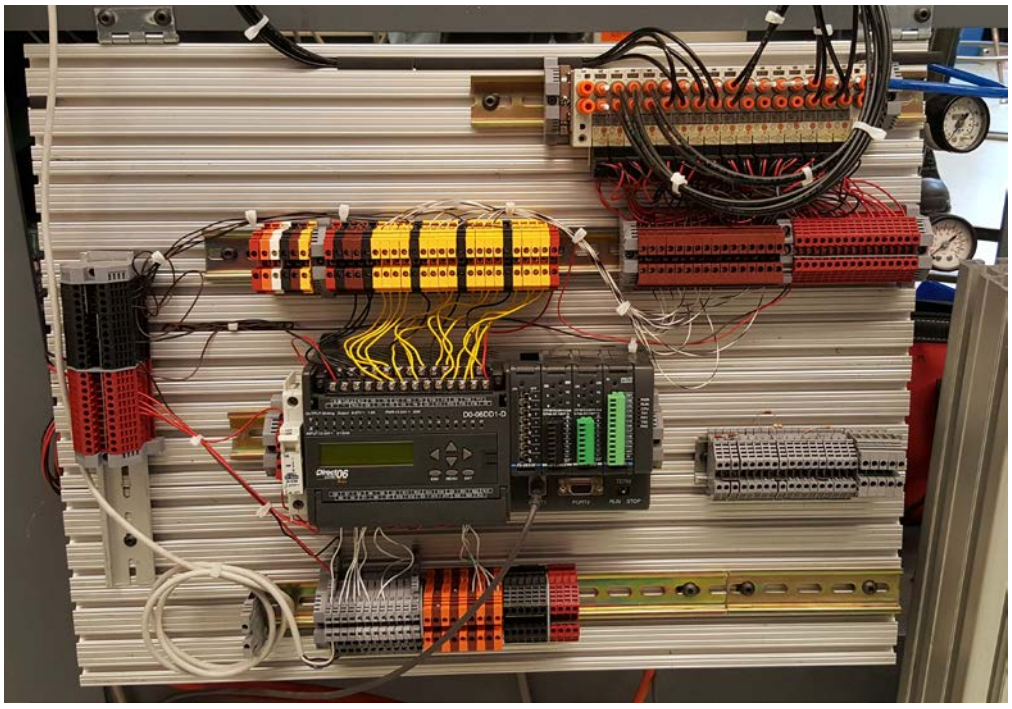
Stage 4 is used to remove the completed assembly from the jig and place it on a conveyor belt. This stage is composed of the following parts: one grabber, one pneumatic linear actuator, one pneumatic rotator, one conveyor belt and motor.

The grabber is mounted to the linear actuator so that the grabber is vertical with the tongs on the lower end. The linear actuator is mounted so that the movement it creates is vertical and is attached at the lower end to the pneumatic rotator. The rotator is set to rotate between the jig and the conveyor belt, and can be adjusted as needed to achieve the desired angle. The process that this stage undergoes is the linear actuator lowers, the grabber closes, grabbing the assembly. The linear actuator lifts and the rotator rotates. At this point the linear actuator lowers and the grabbers release placing the part on the conveyor belt. The linear actuator raises and rotates back to the starting position.

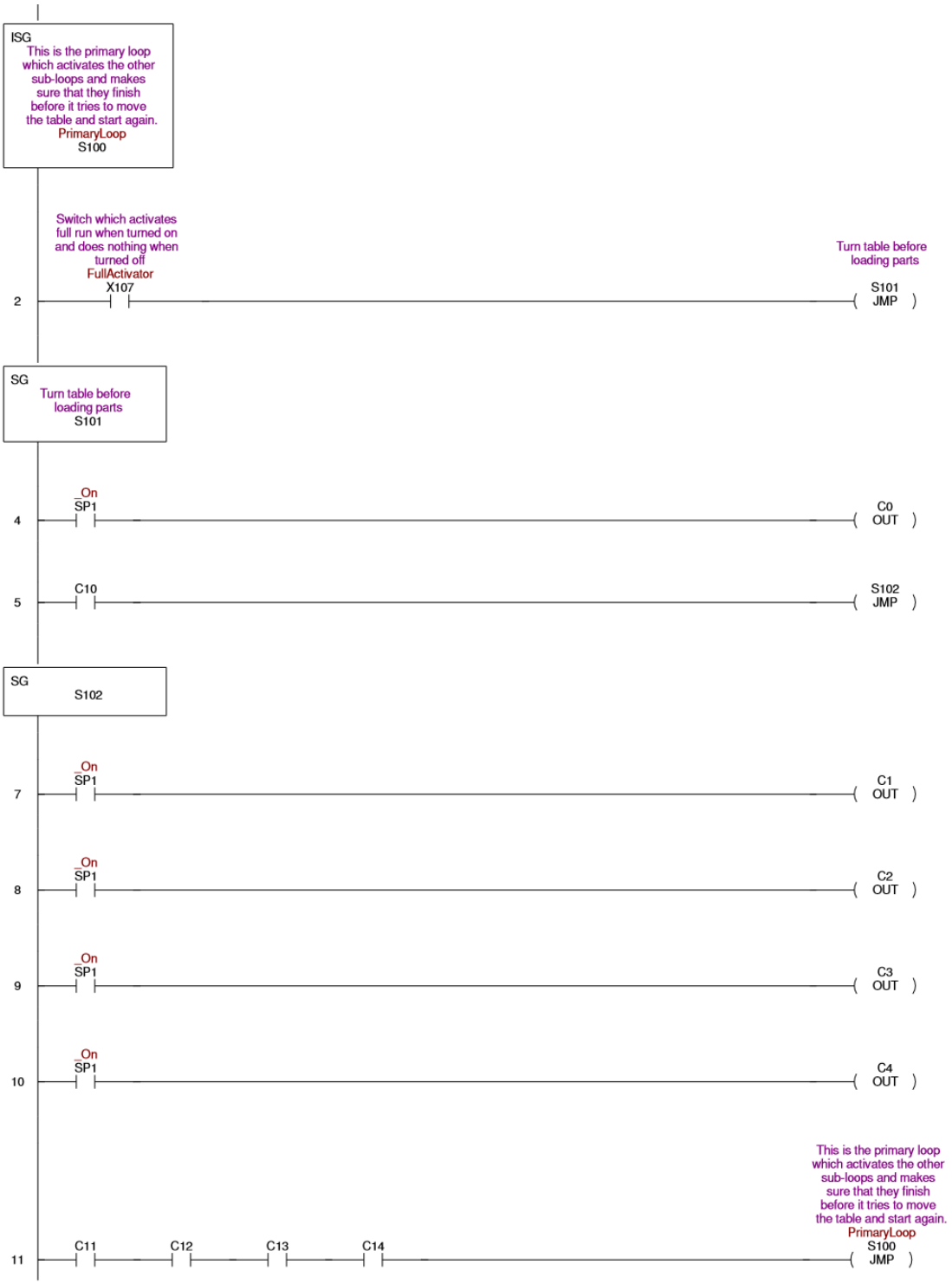


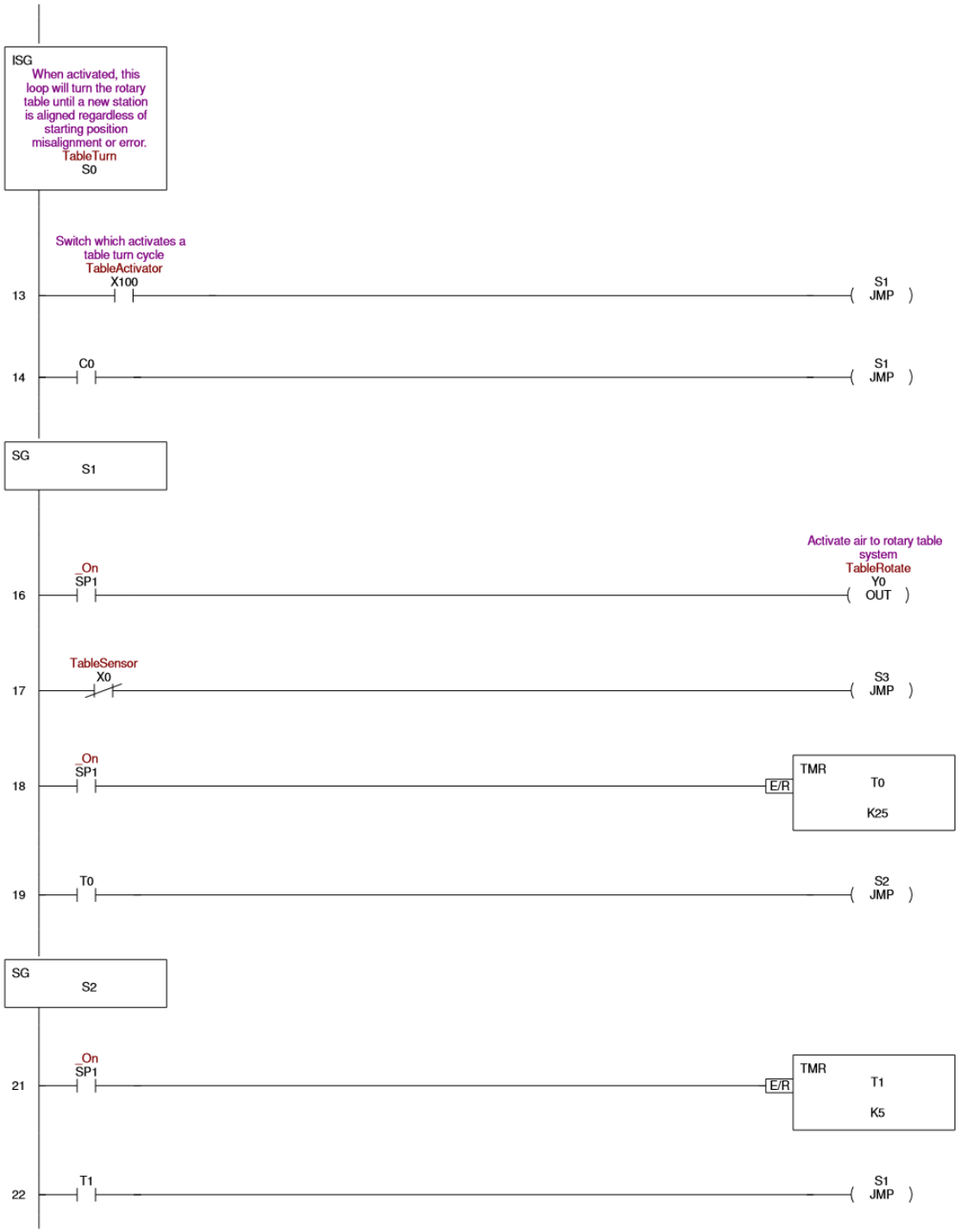
# 7 PLC

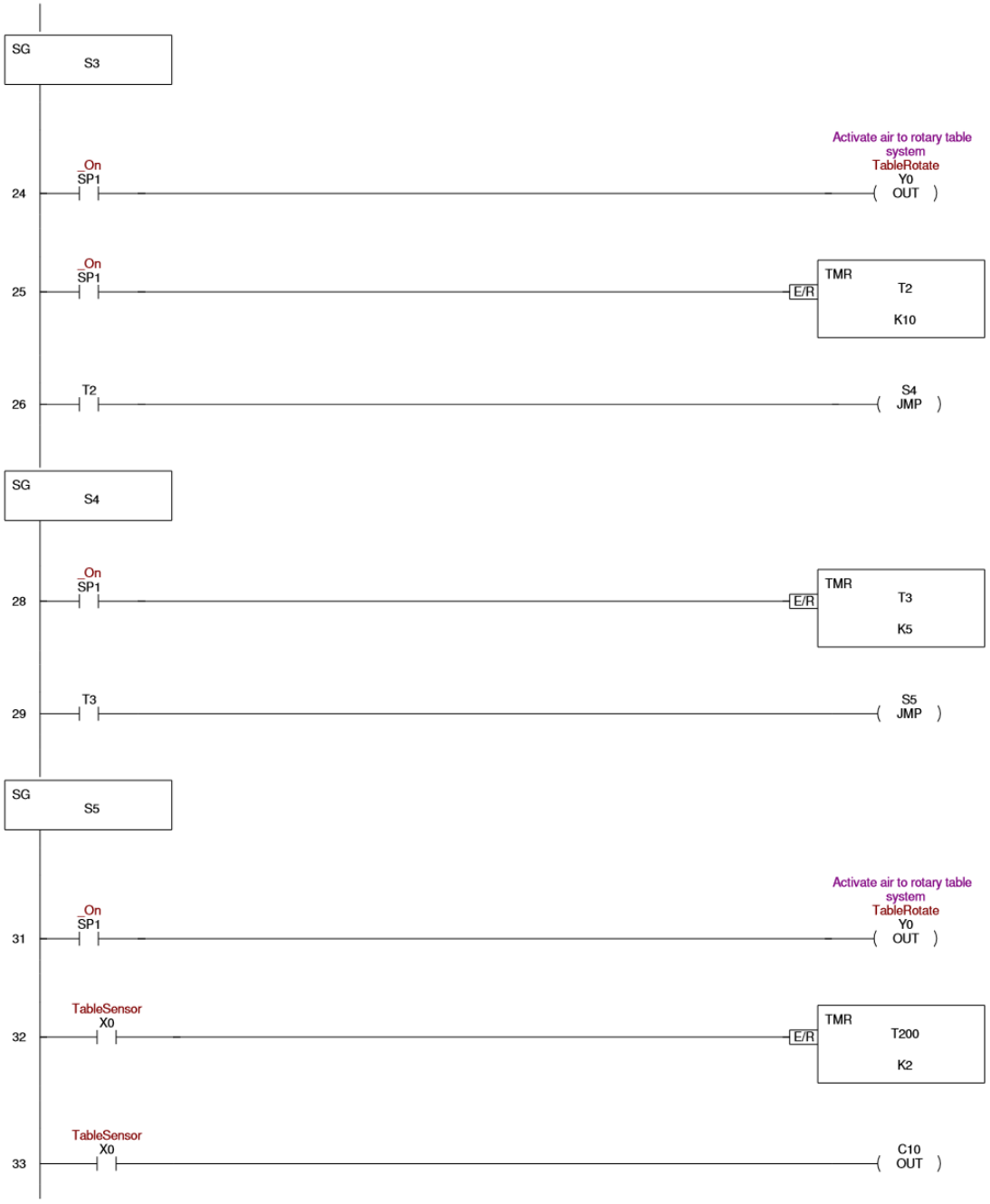
The Programmable Logic Controller (PLC) for this project is a Direct Logic 06 D0-06DD1-D with a F0-08SIM switch module installed.

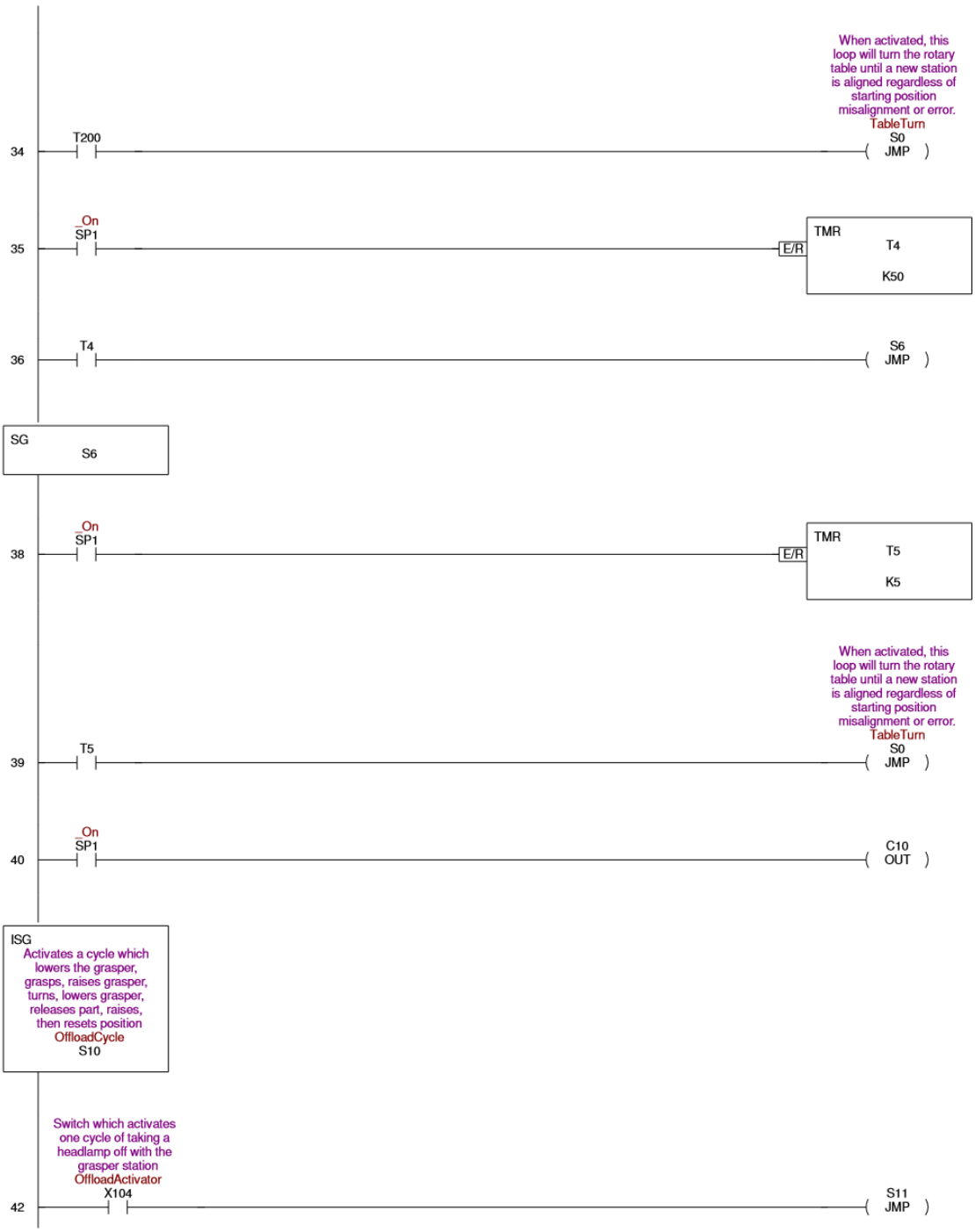


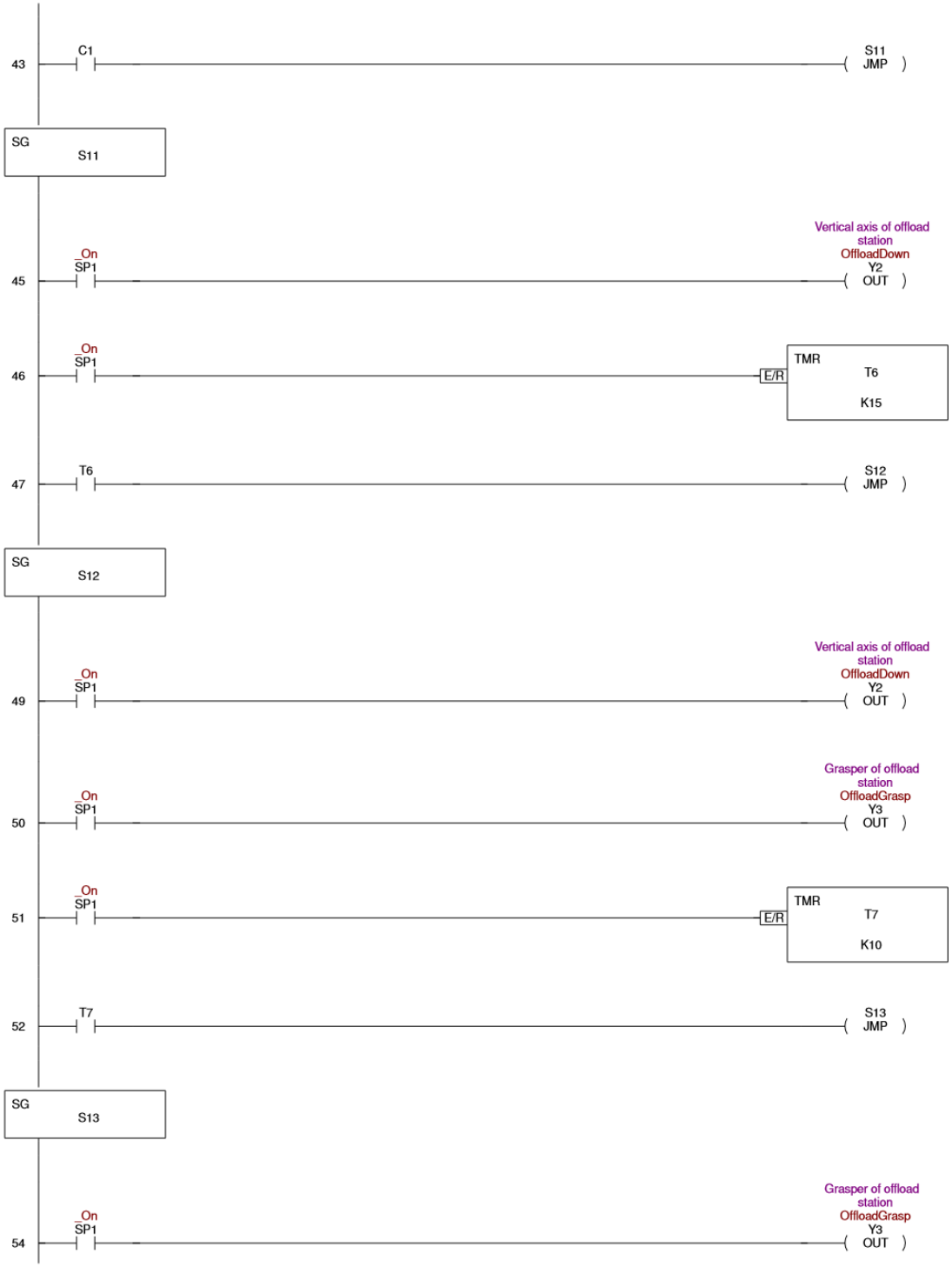
A copy of the code used with additional comments is found on the following pages:

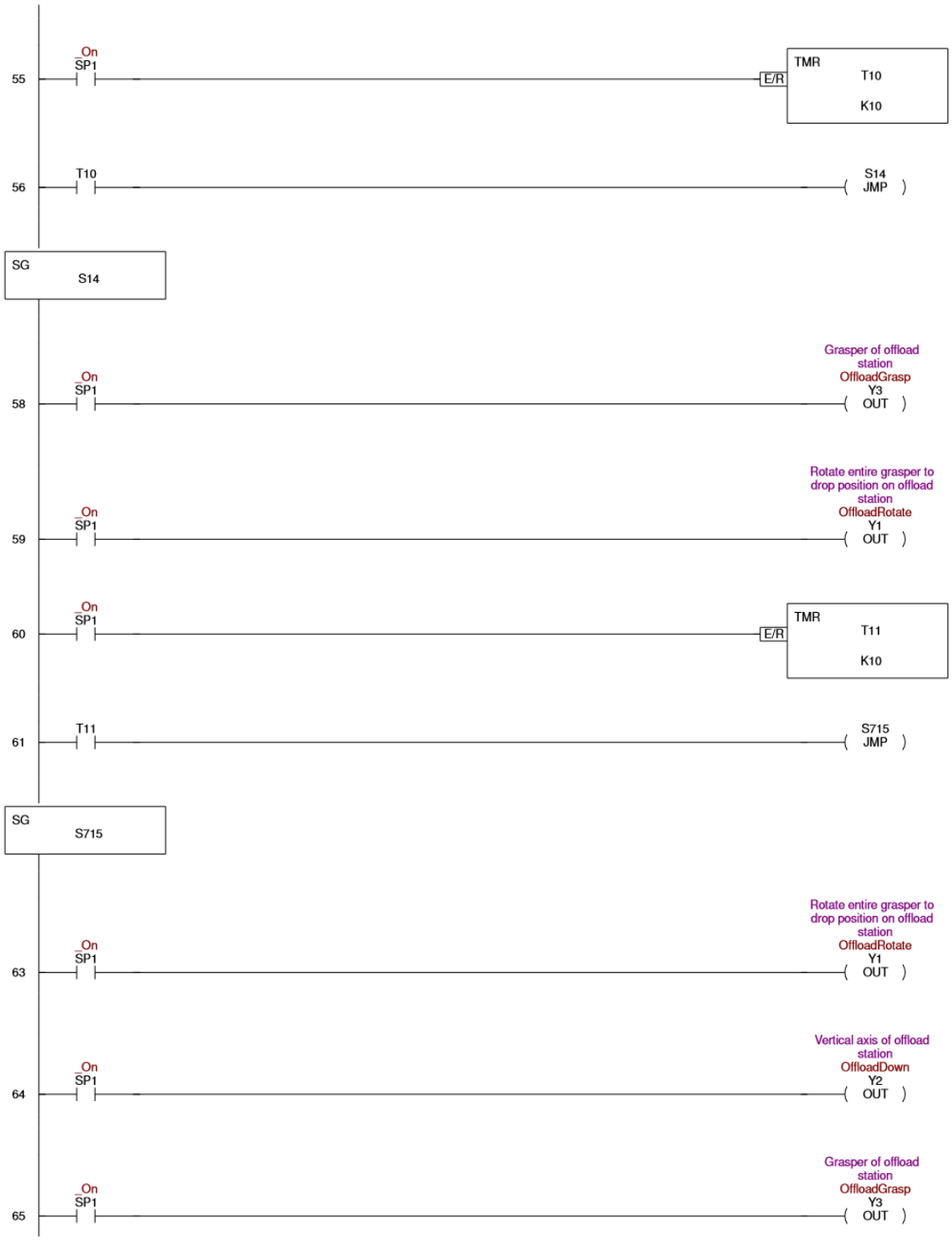

ISG
This is the primary loop which activates the other sub-loops and makes sure that they finish before it tries to move the table and start again.
PrimaryLoop
S100
Switch which activates full run when turned on and does nothing when turned off
FullActivator
X107
Turn table before loading parts
S101
JMP
2
SG
Turn table before loading parts
S101
_On
SP1
C0
OUT
4
C10
S102
JMP
5
SG
S102
_On
SP1
C1
OUT
7
C2
8
C3
9
C4
10
This is the primary loop which activates the other sub-loops and makes sure that they finish before it tries to move the table and start again.
PrimaryLoop
S100
JMP
C11
C12
C13
C14
11

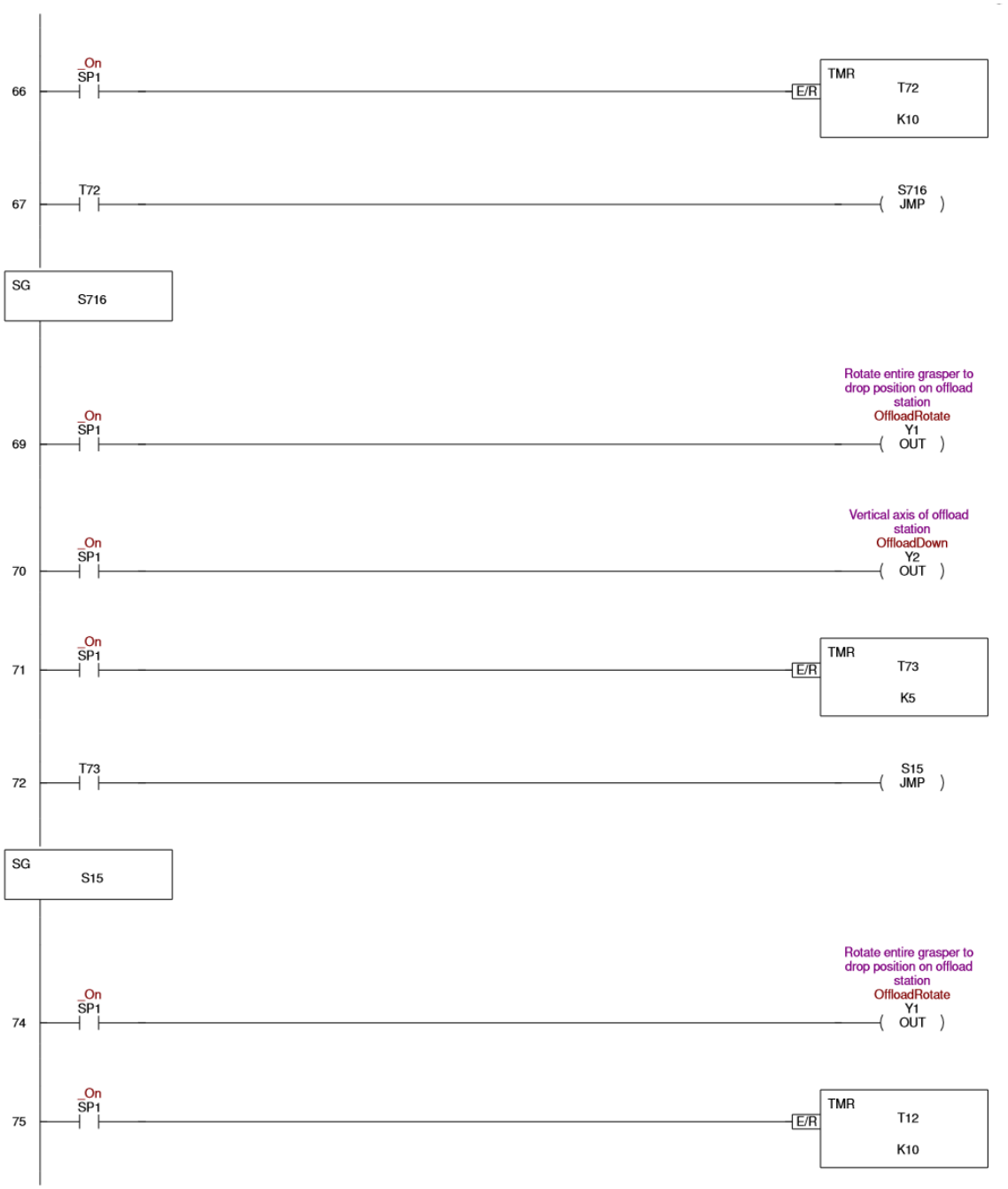

ISG
When activated, this loop will turn the rotary table until a new station is aligned regardless of starting position misalignment or error.
TableTurn
S0
Switch which activates a table turn cycle
TableActivator
X100
13
S1
JMP
C0
14
S1
JMP
SG
S1
Activate air to rotary table system
TableRotate
Y0
OUT
_On
SP1
16
TableSensor
X0
17
S3
JMP
_On
SP1
18
E/R
TMR
T0
K25
T0
19
S2
JMP
SG
S2
_On
SP1
21
E/R
TMR
T1
K5
T1
22
S1
JMP

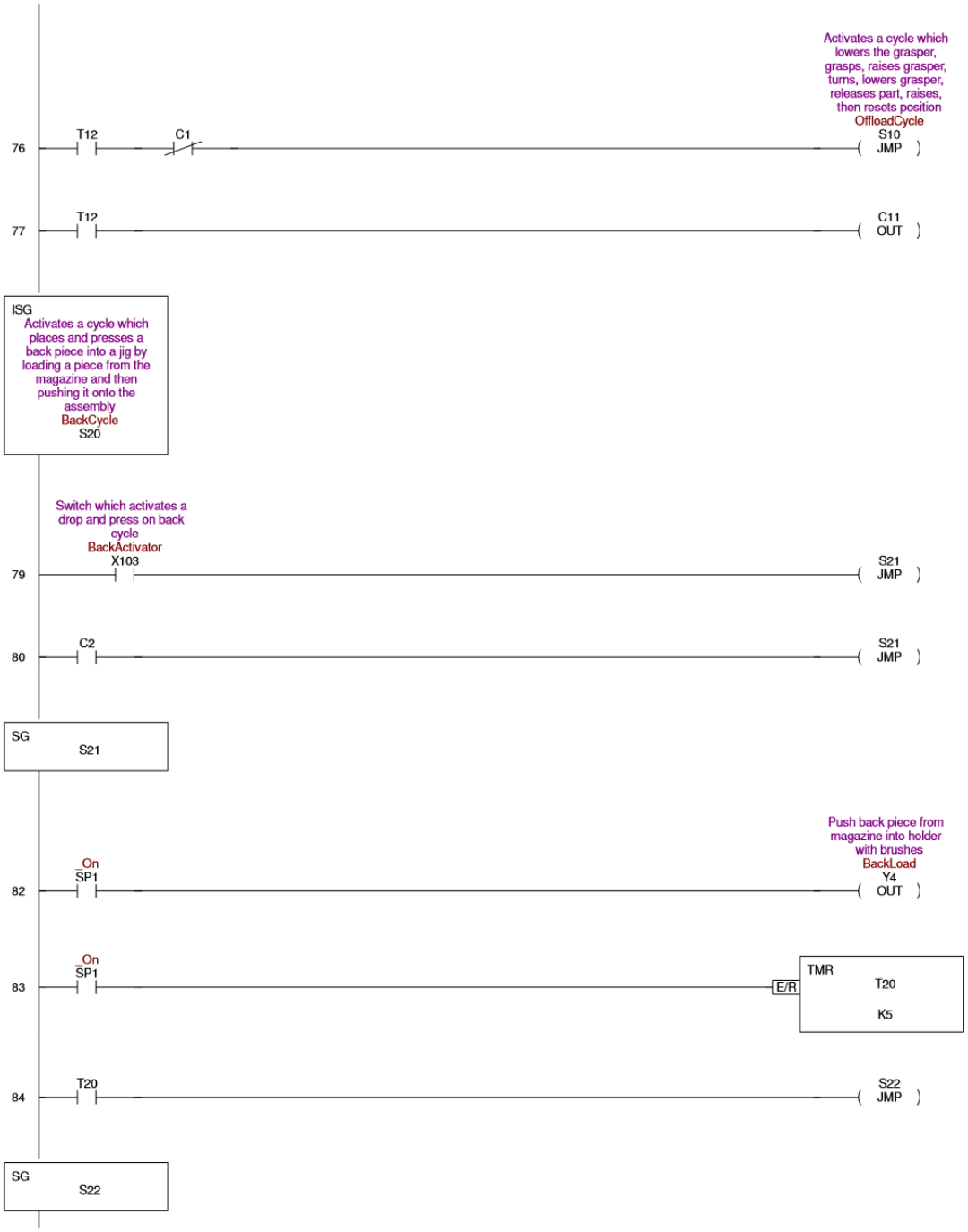

SG
S3
Activate air to rotary table system
TableRotate
Y0
_On
SP1
24
OUT
_On
SP1
25
TMR
E/R
T2
K10
T2
26
S4
JMP
SG
S4
_On
SP1
28
TMR
E/R
T3
K5
T3
29
S5
JMP
SG
S5
Activate air to rotary table system
TableRotate
Y0
_On
SP1
31
OUT
TableSensor
X0
32
TMR
E/R
T200
K2
TableSensor
X0
33
C10
OUT

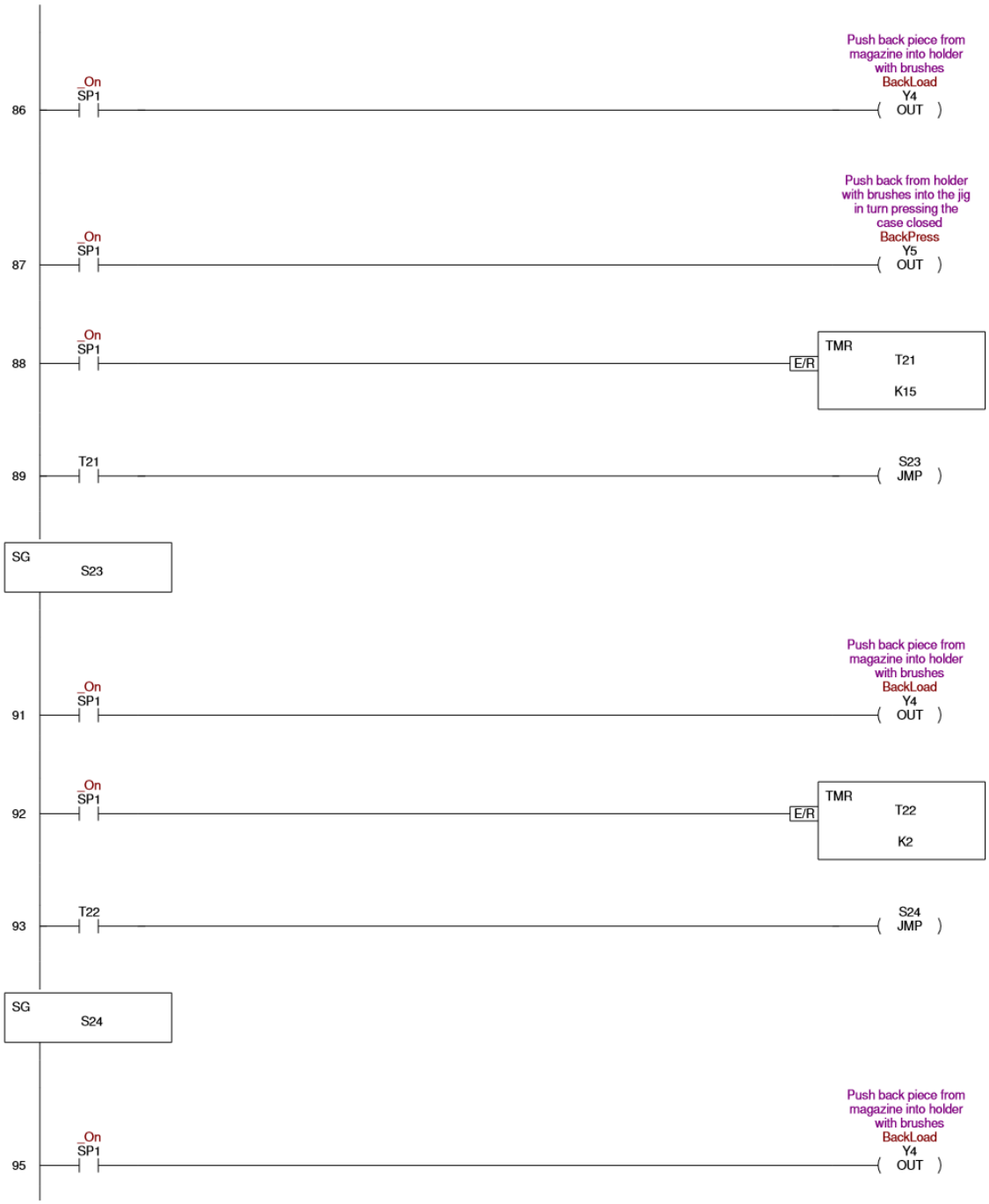

When activated, this loop will turn the rotary table until a new station is aligned regardless of starting position misalignment or error.
TableTurn
34
T200
S0
JMP
_On
SP1
35
E/R
TMR
T4
K50
36
T4
S6
JMP
SG
S6
38
_On
SP1
E/R
TMR
T5
K5
When activated, this loop will turn the rotary table until a new station is aligned regardless of starting position misalignment or error.
TableTurn
39
T5
S0
JMP
40
_On
SP1
C10
OUT
ISG
Activates a cycle which lowers the grasper, grasps, raises grasper, turns, lowers grasper, releases part, raises, then resets position
OffloadCycle
S10
Switch which activates one cycle of taking a headlamp off with the grasper station
OffloadActivator
42
X104
S11
JMP

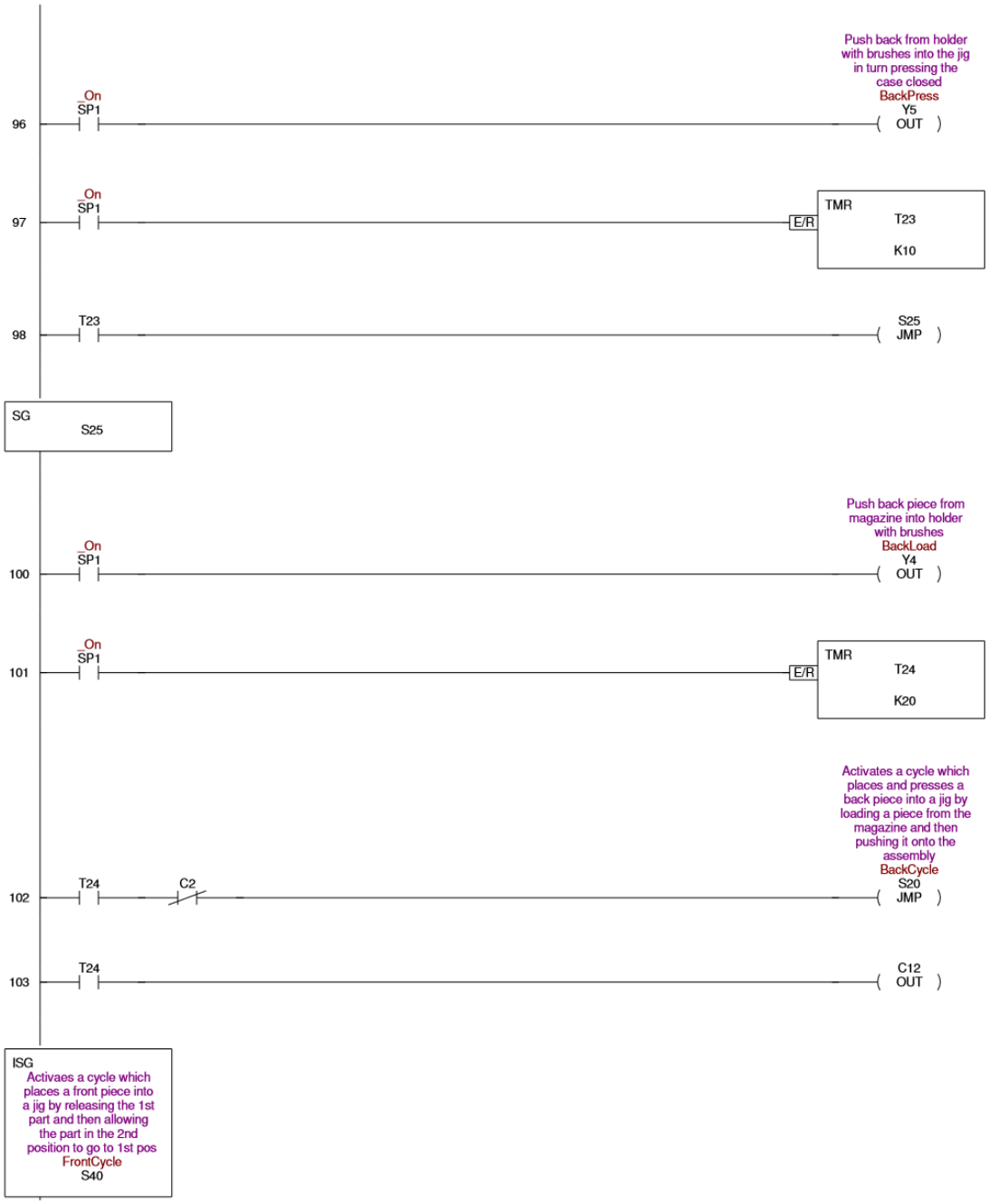

43
C1
S11
JMP
SG
S11
45
_On
SP1
Vertical axis of offload station
OffloadDown
Y2
OUT
46
_On
SP1
E/R
TMR
T6
K15
47
T6
S12
JMP
SG
S12
49
_On
SP1
Vertical axis of offload station
OffloadDown
Y2
OUT
50
_On
SP1
Grasper of offload station
OffloadGrasp
Y3
OUT
51
_On
SP1
E/R
TMR
T7
K10
52
T7
S13
JMP
SG
S13
54
_On
SP1
Grasper of offload station
OffloadGrasp
Y3
OUT

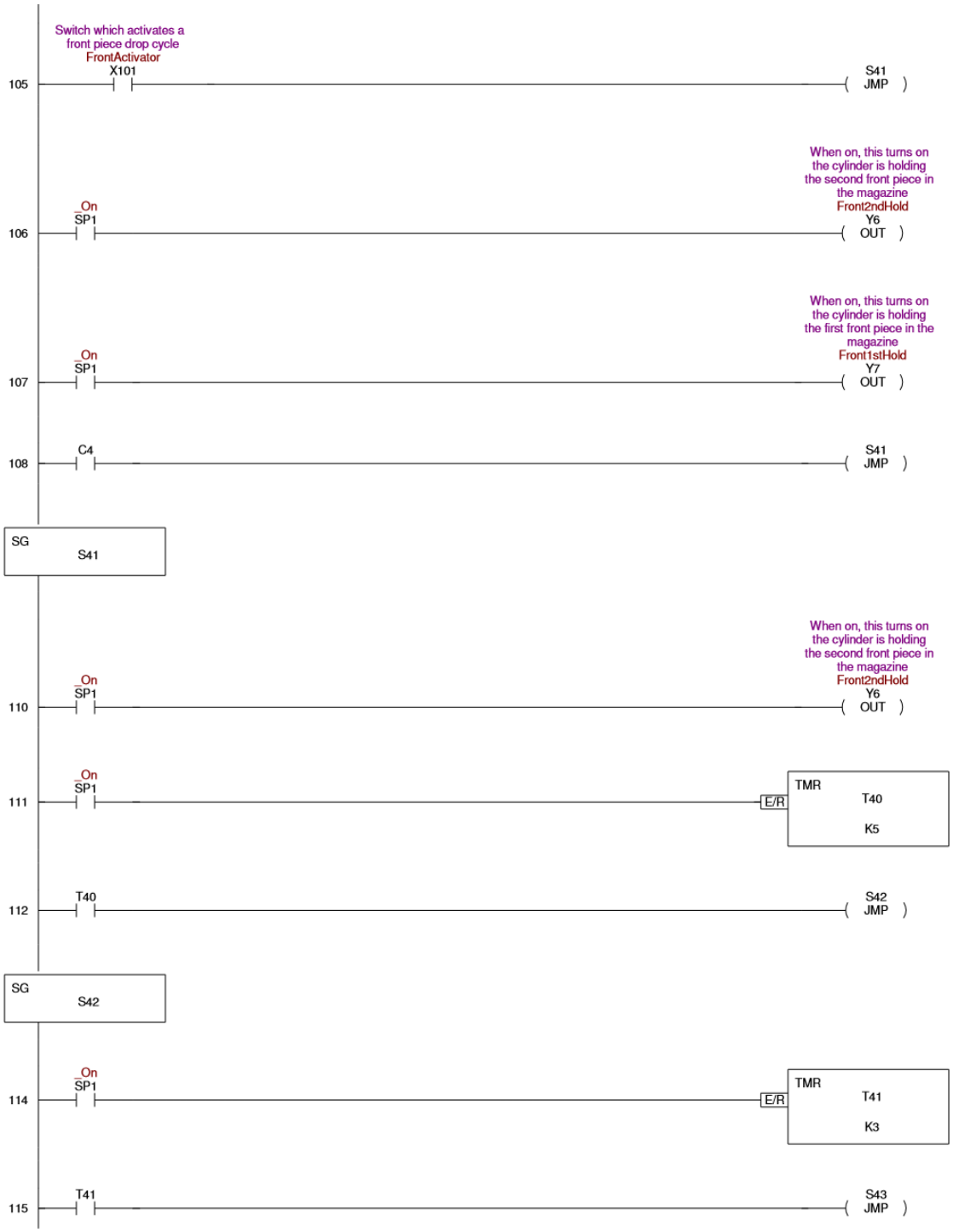

55
_On
SP1
E/R
TMR
T10
K10
56
T10
S14
JMP
SG
S14
58
_On
SP1
Grasper of offload station
OffloadGrasp
Y3
OUT
59
_On
SP1
Rotate entire grasper to drop position on offload station
OffloadRotate
Y1
OUT
60
_On
SP1
E/R
TMR
T11
K10
61
T11
S715
JMP
SG
S715
63
_On
SP1
Rotate entire grasper to drop position on offload station
OffloadRotate
Y1
OUT
64
_On
SP1
Vertical axis of offload station
OffloadDown
Y2
OUT
65
_On
SP1
Grasper of offload station
OffloadGrasp
Y3
OUT

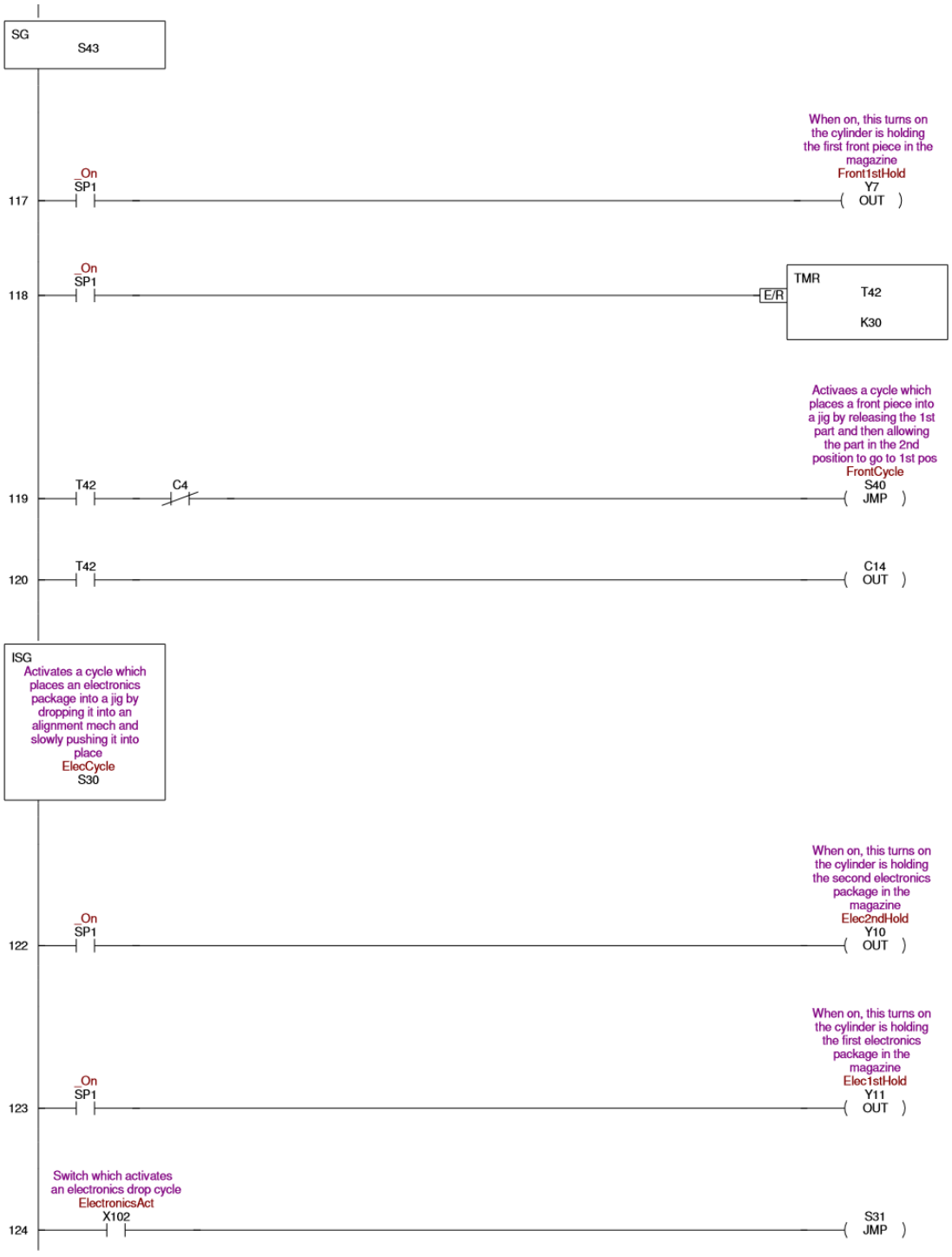

66
_On
SP1
E/R
TMR
T72
K10
67
T72
S716
JMP
SG
S716
Rotate entire grasper to drop position on offload station
OffloadRotate
69
_On
SP1
Y1
OUT
Vertical axis of offload station
OffloadDown
70
_On
SP1
Y2
OUT
71
_On
SP1
E/R
TMR
T73
K5
72
T73
S15
JMP
SG
S15
Rotate entire grasper to drop position on offload station
OffloadRotate
74
_On
SP1
Y1
OUT
75
_On
SP1
E/R
TMR
T12
K10

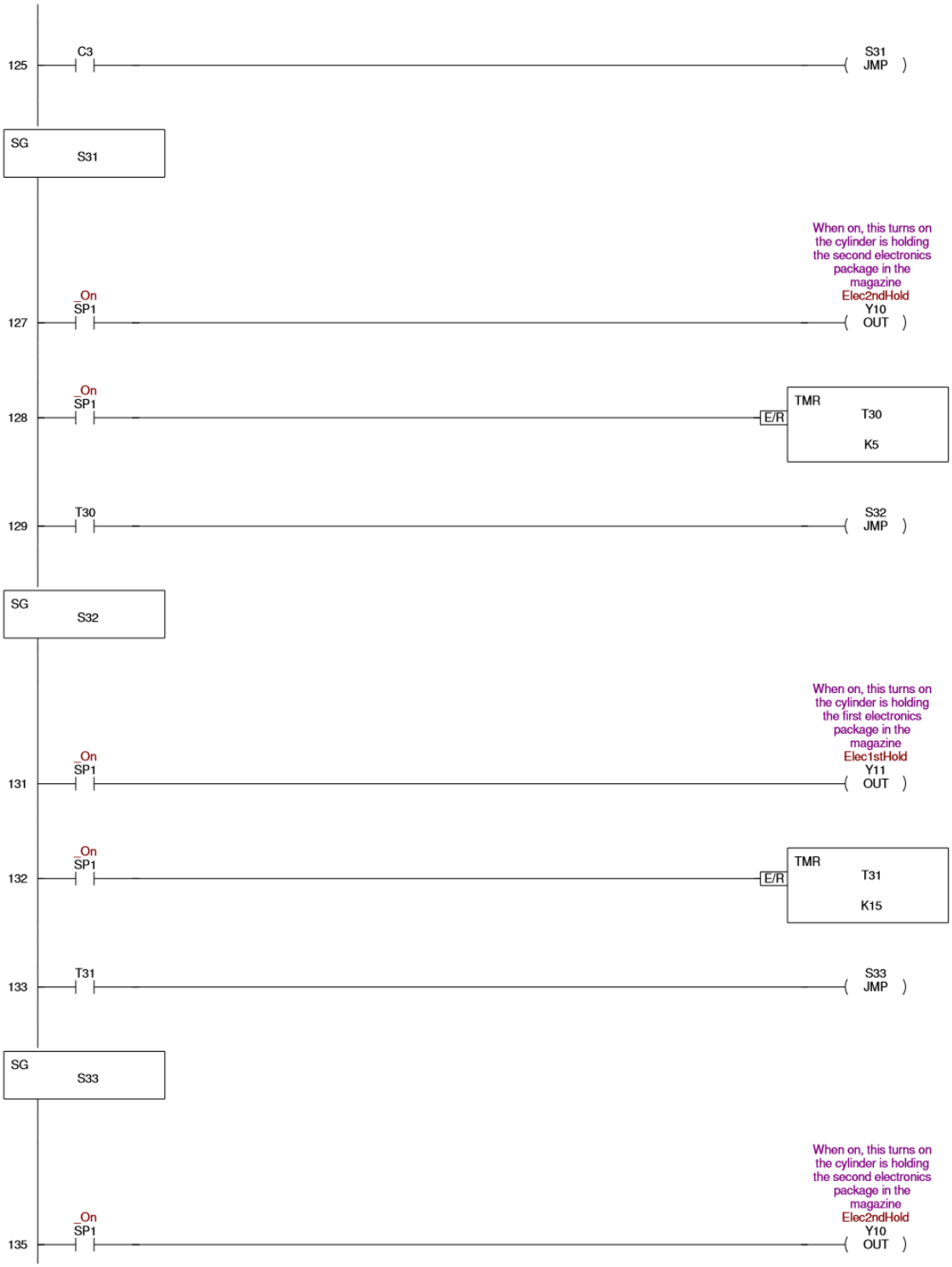

Activates a cycle which lowers the grasper, grasps, raises grasper, turns, lowers grasper, releases part, raises, then resets position
OffloadCycle
76
T12
C1
S10
JMP
77
T12
C11
OUT
ISG
Activates a cycle which places and presses a back piece into a jig by loading a piece from the magazine and then pushing it onto the assembly
BackCycle
S20
Switch which activates a drop and press on back cycle
BackActivator
79
X103
S21
JMP
80
C2
S21
JMP
SG
S21
Push back piece from magazine into holder with brushes
BackLoad
82
_On
SP1
Y4
OUT
83
_On
SP1
E/R
TMR
T20
K5
84
T20
S22
JMP
SG
S22

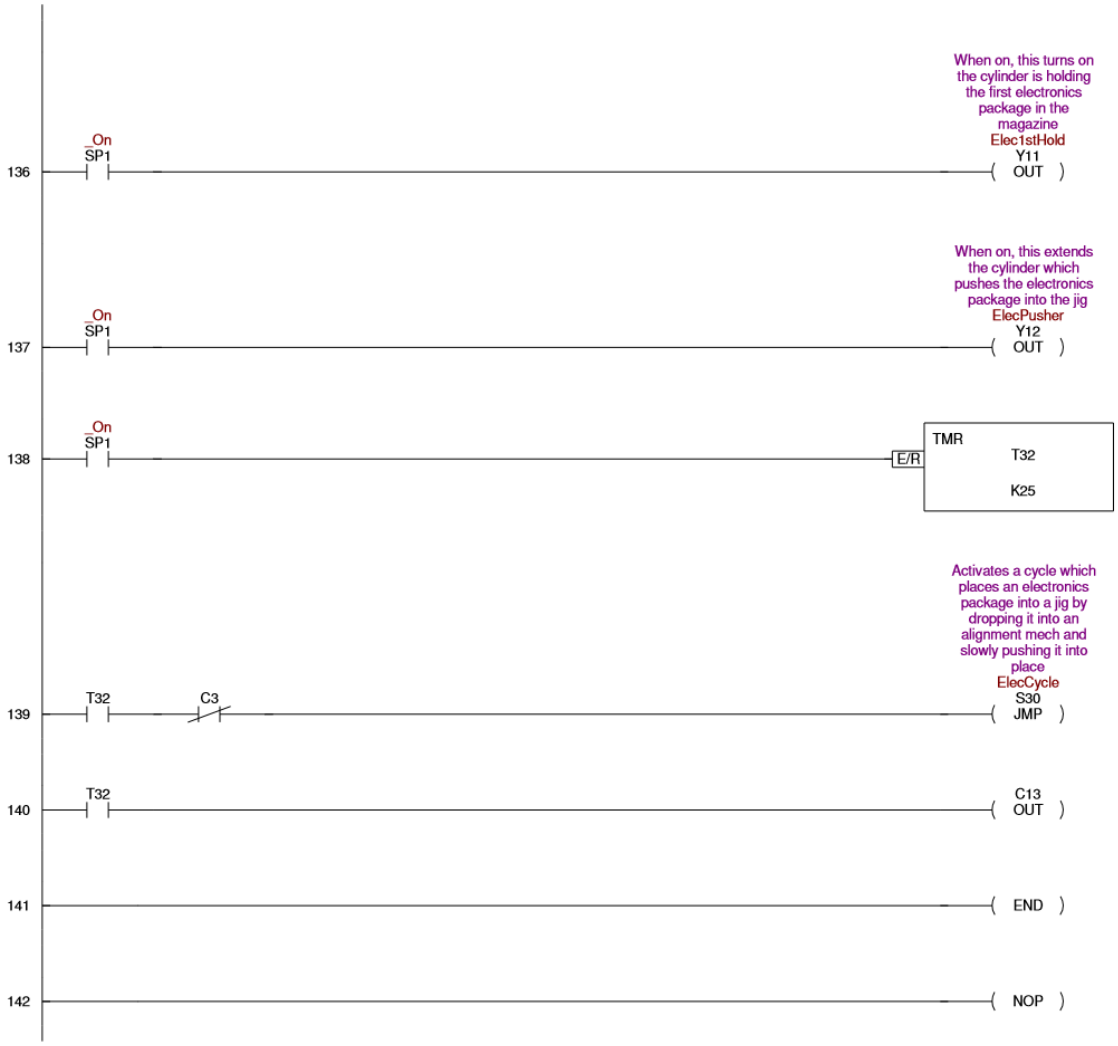

Push back piece from magazine into holder with brushes
BackLoad
Y4
OUT
_On
SP1
86
Push back from holder with brushes into the jig in turn pressing the case closed
BackPress
Y5
OUT
87
TMR
T21
K15
E/R
88
S23
JMP
T21
89
SG
S23
Push back piece from magazine into holder with brushes
BackLoad
Y4
OUT
91
TMR
T22
K2
92
S24
JMP
T22
93
SG
S24
Push back piece from magazine into holder with brushes
BackLoad
Y4
OUT
95


Push back from holder with brushes into the jig in turn pressing the case closed
BackPress
Y5
OUT
_On
SP1
96
97
TMR
T23
K10
E/R
98
T23
S25
JMP
SG
S25
Push back piece from magazine into holder with brushes
BackLoad
Y4
100
101
T24
K20
Activates a cycle which places and presses a back piece into a jig by loading a piece from the magazine and then pushing it onto the assembly
BackCycle
S20
102
C2
103
C12
ISG
Activaes a cycle which places a front piece into a jig by releasing the 1st part and then allowing the part in the 2nd position to go to 1st pos
FrontCycle
S40


Switch which activates a front piece drop cycle
FrontActivator
X101
105
S41
JMP
When on, this turns on the cylinder is holding the second front piece in the magazine
Front2ndHold
Y6
106
_On
SP1
OUT
When on, this turns on the cylinder is holding the first front piece in the magazine
Front1stHold
Y7
107
_On
SP1
OUT
108
C4
S41
JMP
SG
S41
When on, this turns on the cylinder is holding the second front piece in the magazine
Front2ndHold
Y6
110
_On
SP1
OUT
111
_On
SP1
E/R
TMR
T40
K5
112
T40
S42
JMP
SG
S42
114
_On
SP1
E/R
TMR
T41
K3
115
T41
S43
JMP


SG
S43
When on, this turns on the cylinder is holding the first front piece in the magazine
Front1stHold
_On
SP1
117
Y7
OUT
_On
SP1
118
TMR
E/R
T42
K30
Activaes a cycle which places a front piece into a jig by releasing the 1st part and then allowing the part in the 2nd position to go to 1st pos
FrontCycle
T42
C4
119
S40
JMP
T42
120
C14
OUT
ISG
Activates a cycle which places an electronics package into a jig by dropping it into an alignment mech and slowly pushing it into place
ElecCycle
S30
When on, this turns on the cylinder is holding the second electronics package in the magazine
Elec2ndHold
_On
SP1
122
Y10
OUT
When on, this turns on the cylinder is holding the first electronics package in the magazine
Elec1stHold
_On
SP1
123
Y11
OUT
Switch which activates an electronics drop cycle
ElectronicsAct
X102
124
S31
JMP


125
C3
S31
JMP
SG
S31
When on, this turns on the cylinder is holding the second electronics package in the magazine
Elec2ndHold
Y10
127
_On
SP1
OUT
128
_On
SP1
E/R
TMR
T30
K5
129
T30
S32
JMP
SG
S32
When on, this turns on the cylinder is holding the first electronics package in the magazine
Elec1stHold
Y11
131
_On
SP1
OUT
132
_On
SP1
E/R
TMR
T31
K15
133
T31
S33
JMP
SG
S33
When on, this turns on the cylinder is holding the second electronics package in the magazine
Elec2ndHold
Y10
135
_On
SP1
OUT


When on, this turns on the cylinder is holding the first electronics package in the magazine
Elec1stHold
136
_On
SP1
Y11
OUT
When on, this extends the cylinder which pushes the electronics package into the jig
ElecPusher
137
_On
SP1
Y12
OUT
138
_On
SP1
E/R
TMR
T32
K25
Activates a cycle which places an electronics package into a jig by dropping it into an alignment mech and slowly pushing it into place
ElecCycle
139
T32
C3
S30
JMP
140
T32
C13
OUT
141
END
142
NOP